

Research regarding the development and evaluation of agility (balance, coordination and speed) in children aged 9-10 years

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Abstract

Background. Physical education in school is a crucial activity in establishing a well-balanced and harmonious body from young children to teenagers, developing motor skills, personality traits and building strong and durable relationships. One of the most important motor skills developed in physical education, in school, is the combination of speed, coordination and balance named nowadays agility. More authors described agility as being the capacity to quickly change direction, having high levels of speed and coordination, being well-balanced and creative.

Aims. The present study followed the idea of finding and evaluating the level of agility development in primary school children aged between 9 and 10 years old. The research group was composed of children from two Romanian schools: School “Mihai Eminescu” and School “George Popa” from Medias — Sibiu, with a sample of 105 children (49 males and 56 females) aged between nine and ten years old. The program of improvement was implemented 15 minutes in every physical education class for a 3-month period in 2019.

Methods. The research method used was an experimental method using two agility tests (the Agility T test and the Agility L test) whose purpose was to evaluate the initial and final level of agility. For statistical interpretation, the t-Student test, Mann-Whitney test and Welch correlation were used.

Results. The results in both agility tests showed improved results from the initial test to the final test after the 3-month training period. A statistically significant difference was found comparing the initial and final results of the male subjects in both schools in agility T test and also in agility L test. In addition, a statistically significant difference was demonstrated between the initial and final evaluation in female subjects by agility L test and by comparing the initial and final results of females between schools using the agility T test.

Conclusions. The conclusions of our experiment showed that the hypothesis was confirmed that following implementation of a specific program of development of combined motor qualities, speed and coordination (agility) can be improved and significantly better results in the two applied tests, between the initial and the final testing, can be obtained. Developing agility at young ages can contribute to a future athlete’s sport career by building a strong foundation of motor skills.

Keywords: agility, speed, coordination, dynamic balance, body movement.

Introduction

Depending on the area to which we refer, the term movement may have different meanings. In the field of physical exercise practice, movement represents “the ability of an individual to travel from point to point, with the purpose of changing the position of the body or the different body segments, to move, to interact with other individuals and to act in the environment (physical or social)”. Depending on its nature, movements can be voluntary, non-voluntary, cyclic, acyclic, automatic, passive, active, uniform, accelerated, etc. All these represent types or genres of movement (Hantiu, 2013a).

Motor qualities or skills are defined by some authors as those characteristics of the body that materialize in the body’s ability to perform movements with certain speed, strength, coordination or resistance indices. They are present in all the motor acts of individuals, each of them requiring a certain degree of manifestation of the others (Hantiu, 2013b).

Neagu (2012) asserted that although aptitudes largely belong to the genetic portfolio of an individual, they have in their composition a series of phenotypic elements (under the influence of the educational environment, for example), participating in their translation (through

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developing processes) from predisposing primary forms to increasingly refined, superior forms, defined in the form of talent, skill, etc.

In another form, motor skills can be defined as those predominantly endogenous individual characteristics—hereditary predispositions—with a share of exogenous influences—of an instructive-educational nature, which determine external motor manifestations, the actual movements, respectively (Neagu, 2012).

Motor qualities are considered important for the physical, mental and social evolution of children (Gallahue & Ozmun, 2002) and may even be the foundation of an active and healthy lifestyle, as many studies have shown a positive association between good motor skills and higher levels of physical activity. For example, it has been shown that a good index of the level of motor qualities has positive effects on health, effectively influencing the improvement of the cardiorespiratory capacity, the maintenance of an optimal body weight, the improvement of the level of practice and daily activities, the development of the executive function of the body, etc. (Lubans et al., 2010; Fisher et al., 2005; Williams et al., 2008; Krombholz, 2013).

The musculoskeletal and postural aesthetic deficiencies of human beings are in full ascension due to the new modern lifestyle and lack of concern for the prevention of their appearance, thus resulting in pronounced somatic disabilities (Vos et al., 2010). Research conducted in the last decade shows that biomechanical disorders start at an early age, and that problems emerging during this period can be present throughout life. Thus, a child who has physical pain during this period of development may experience pain even in adulthood (Hestbaek et al., 2006). It is very important to point out that these musculoskeletal disorders can have serious consequences on the physical and mental development of the child. A child with physical deficiencies will have a more withdrawn behavior, will be tempted to give up social activities that may have benefits on different levels and will present a major risk of behavioral underdevelopment. Last but not least, that child will be tempted to give up physical and sports activities, which play a very important role in maintaining health, thus being prone to other physiological problems, such as cardiovascular problems, diabetes, etc. (Andersen et al., 2016).

Several scientific sports studies concluded that one of the most important elements of the agility skill is speed or the rapid movement of the body. Older definitions of the agility skill are considered by many too basic and simplistic; the basic or the basic elements of the agility skill are more likely to be: balance of the body, coordination of parts of the body or the entire body, also the ability or the possibility of athletes to adapt and have rapid reactions to a change of the environment or different situations (Plisk, 2008). More and more specialists consider nowadays that the agility technique is a more complex motor skill and consider agility among the mixed physical motor skills composed of a combination of basic motor skills (Mekota, 2000). Although speed is a fundamental component of the agility skill, scientists affirm that it must not be confused or misinterpreted, and one must not put an equal sign between

speed and agility; agility has more components and can be superior to speed or quickness; this combined ability also has coordination and balance abilities.

The newer investigation in sports research concluded that speed ability and agility motor quality represent independent and different physical motor abilities and in the process of their development they require a high level of muscular specificity development (Sheppard & Young, 2006). Particular attention should be given to the development of the agility skill, to the anticipation and decision-making abilities (Young et al., 2002). Also, the speed and agility techniques involve moving the whole body very quickly, but unlike the speed skill, the attribute of changing direction is added to the agility skill.

A general definition of agility that is accepted by many sports scientists presents the agility skill as “a rapid whole-body movement with modification of running direction in response to a stimulus” (Van Gelder & Bartz, 2011). The agility skill implies the movement of the entire body or only of the upper or lower body segments to rapidly change the running direction without losing precision or balance (Allum et al., 2002).

The fundamental components of the agility skill are coordination and movement control, but they must be taken into account apart from the other components that affect the level of agility development, such as dynamic balance, mobility of joints, power of the body, and flexibility or elasticity, levels of energy resources, strength, speed and biomechanical structure of movement (Sporis et al., 2010).

Objectives

This research was aimed at examining several important phenomena, which must be studied in the field of physical education and sport. Some of the most important tasks of the research are the importance of educating and developing motor qualities in children, the motor skills examined in this study being speed and coordination, tested and interpreted in a combined and unitary way, through a series of motor activities corresponding to their studies.

Hypothesis

In the present research, we started from the hypothesis that tracking the application of our specific program of development of the combined motor qualities, speed and coordination (agility), we will obtain significantly better results in the two applied tests, between the initial and the final testing. This program was implemented with the help of specialized teachers in the educational instructional process of physical education and sports lessons, taking place for a period of about 3 months, followed at the end of the testing by data collection and interpretation, to observe the changes resulting in the motor skills of the studied subjects.

Materials and methods

Research protocol

This investigation was overseen in accordance with the Declaration of Helsinki (2013) and approved by the Ethics Committee before the beginning of the study. It also met the ethical standards for Sport and Exercise Science Research. Due to the fact that the general data protection

regulation entered in force on 25 May 2018 (Regulation (EU) 2016/679), which imposes a single set of rules on personal data protection, the tutors of the investigated subjects were provided with an agreement for recording and using personal data. This agreement was signed in two copies by all tutors and provides for the use of records of some motor parameters, then using them while respecting confidentiality, without using the child's identity.

a) Period and place of the research

The experimenting time frame was extended over a period of 3 months, the initial testing being applied at the beginning of February 2019, over a week. Between the two tests, initial and final, we designed a specific program for the development of the two combined motor qualities, which was used for 15 minutes in each physical education lesson.

The current research and data collection were carried out by means of motor tests, conducted in two state secondary schools in the city of Mediaş - School "George Popa" and School "Mihai Eminescu".

b) Subjects and groups

In order to carry out this study, we decided to choose a sample of 105 children aged between 9 and 10 years (49 boys and 56 girls), students of two secondary schools in the city of Mediaş.

Both schools were asked for an agreement to enable them to participate in physical education classes, with the purpose of conducting tests and collecting the data needed for the experiment.

The research was prospective in nature, one of the methods used being the quantitative method, which involves collecting and analyzing the data by performing some tests.

The study was conducted during the hours of physical education and sports and was assisted by the teachers responsible for the class.

c) Tests applied

Data collection was carried out following the application of two agility tests: the "T" test and the "L" test.

- The "T" test

This test includes in its process execution, specific types of actions (running forward, running back, running with added steps and changes in direction), which emphasize the development of combined motor qualities, speed and coordination. Being a test in which the speed level is predominantly targeted, the results will be interpreted in seconds.

Test description:

The test consists of a route, using different forms of running, also including certain changes of direction.

Method of performing the test

The teacher places 3 cones at a distance of 5 meters on a straight line (D, B, C), and a fourth cone (A) is located 10 meters from the middle cone (B) so that the four cones form a "T". Cone "A" will represent the starting point and also the end point of the test.

The subject starts with the "start" command from cone "A"; runs at maximum speed up to cone "B", touches the cone; runs with added steps up to cone "C", touches it; keeps moving at speed with added steps to cone "D", touches it; performs the movement with added steps up to

cone "B", touches it; then runs at speed with the back to the arrival point represented by cone "A".

The teacher will note the time of each subject separately.

- The "L" test

The "L" test is efficient for monitoring the speed of movement, multidirectional speed and the coordination of the psychomotor system of the body, responsible for adapting the movements, with the purpose of performing it in the most efficient possible way.

Description of the test

The teacher places 3 cones (A, B, C) at a distance of 5 meters from one other, imitating the shape of the letter "L".

The test will start from the right of step (A), with the face to step (B).

At the "start" signal, the subject runs at speed to step (B), touches it; turns and runs back towards milestone (A), touches it; then runs towards milestone (C), bypassing milestone (B) from the outside, touches it; runs back to the starting point, again bypassing milestone (B) from the outside, finishing the test after passing it.

The test results were recorded in a table, and then they were centralized and grouped into categories. As analysis methods, statistical analysis and qualitative analysis were used.

d) Statistical processing

Statistical analysis included descriptive statistics (frequency, percentage, mean, median, standard deviation) and inferential statistics. The D'Agostino & Pearson test was applied to determine the distribution of the analyzed data series. For median comparison, the Mann Whitney test and the non-parametric test for unpaired data were applied. The significance threshold chosen for p value was 0.05. Statistical analysis was performed using the GraphPad Prism.

Results

Table I

Results of the "T" and "L" tests in male subjects (initial + final).

Male gender	T Test Initial	T Test Final	L Test Initial	L Test Final
Mean	15.59	15.47	11.83	11.67
Std. deviation	1.591	1.576	0.9465	0.8719
P value	0.0029		P<0.0001	

By analyzing the results presented in Table I, it can be seen that in the male gender the average time obtained in the agility T test, at the initial evaluation, was 15.59±1.591 seconds compared to the final measurement, where we obtained 15.47±1.576 seconds. A 0.12 seconds improvement can be detected, which is considered, using Student t test with a value of p<0.05, to be statistically significant (Table I and Fig. 1).

Also, Table I shows the data for the male gender in the agility L test; at the initial analysis, a result of 11.83 seconds can be seen compared to 11.67 at the final evaluation. The result at the final examination was improved by an average of 0.16 seconds which is considered, using Student t test with a value of p<0.05, to be statistically significant (Table I and Fig. 1).

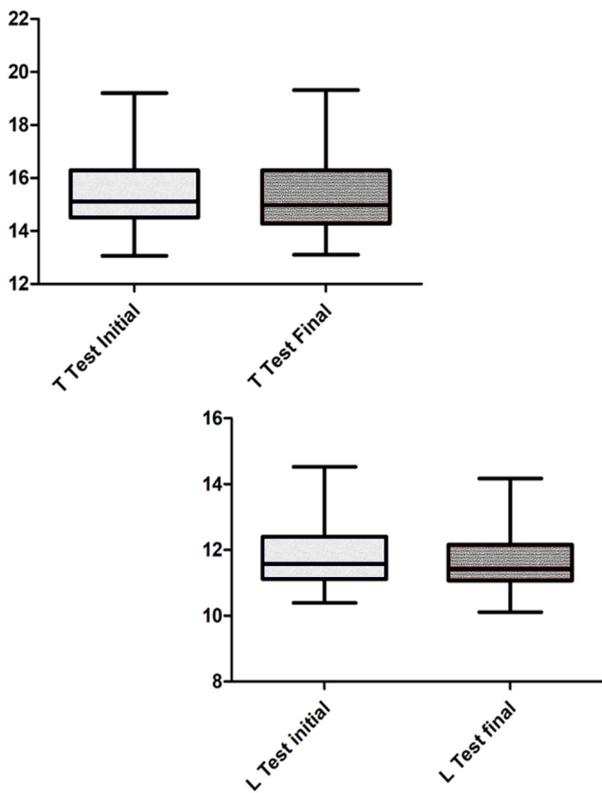


Fig. 1 – The "T" and "L" test results, in male subjects (initial + final in seconds).

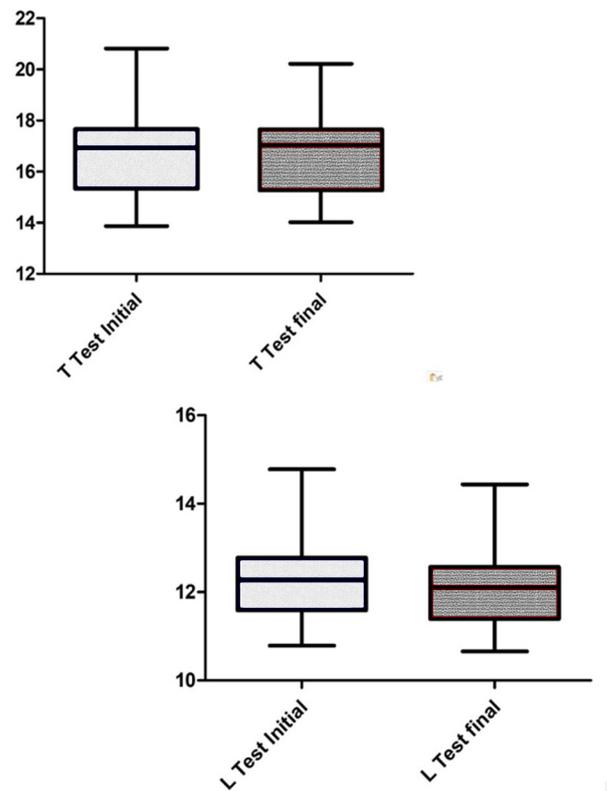


Fig. 2 – The "T" and "L" test results, in female subjects (initial + final in seconds).

Table II

Results of the "T" and "L" tests, in female subjects (initial + final).

Female gender	T Test Initial	T Test Final	L Test Initial	L Test Final
Mean	16.75	16.68	12.27	12.11
Std. deviation	1.537	1.509	0.9253	0.9075
P value	0.1437		P<0.0001	

By analyzing the results presented in Table II, it can be observed that in the female gender, at the agility T test initial evaluation, the average result was 16.75 seconds compared to the final result that was 16.68 seconds, with an improvement of 0.07 seconds from the initial to the final test. The result, using Student t test with a value of $p < 0.05$, is considered not statistically significant in the T test for the female gender (Table II and Fig. 2).

At the agility L test initial evaluation, we registered 12.27 seconds correlated with the final test, where the average was 12.11 seconds, with a 0.16 second improvement. Comparing the results of both calculations, using Student t test with a value of $p < 0.05$, we found a statistically significant difference between the average of the initial and final results in the L-test for the female gender (Table II and Fig. 2).

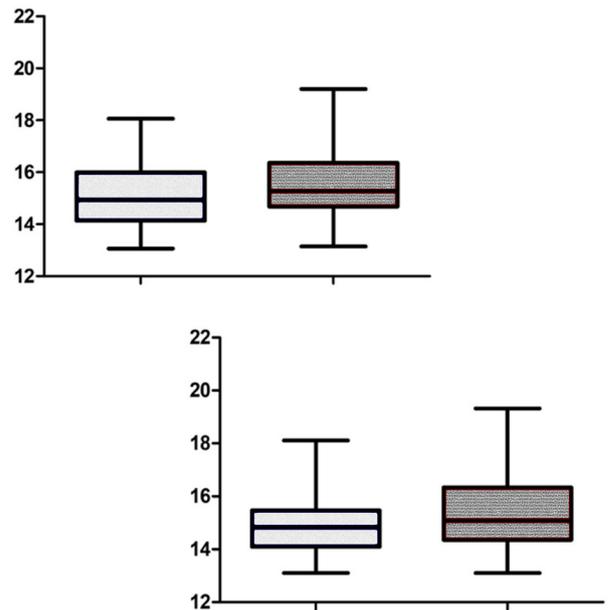


Fig. 3 – Initial and final results in the "T" test, in male subjects, between the two schools, in seconds.

Table III

Initial and final results in the "T" test, in male subjects, between the two schools.

T Test Initial	Male gender		T Test Final	Male gender	
	George Popa school	Mihai Eminescu school		George Popa school	Mihai Eminescu school
Mean	15.18	15.75	Mean	15.06	15.63
Std. deviation	1.476	1.626	Std. deviation	1.416	1.626
P value	0.2612		P value	0.2566	

Table IV

Initial and final results in the "L" test, in male subjects, between the two schools.

L Test Initial	Male gender		L Test Final	Male gender	
	George Popa school	Mihai Eminescu school		George Popa school	Mihai Eminescu school
Mean	11.93	11.79	Mean	11.75	11.64
Std. deviation	0.9378	0.9606	Std. deviation	0.8050	0.9067
P value	0.4386		P value	0.5067	

Table V

Initial and final results in the "T" test, in female subjects, between the two schools.

T Test Initial	Female gender		T Test Final	Female gender	
	George Popa school	Mihai Eminescu school		George Popa school	Mihai Eminescu school
Mean	16.05	17.10	Mean	15.93	17.06
Std. deviation	1.567	1.414	Std. deviation	1.608	1.319
P value	0.0143		P value	0.0069	

By correlating the results obtained by both schools (Table III and Fig. 3), it can be seen that "George Popa" school had an improvement of 0.12 seconds between the initial and final results in the agility T test in the male gender, with an initial result of 15.18 seconds compared to 15.06 seconds. "Mihai Eminescu" school also had an improvement of 0.12 seconds between the initial and final results in the agility T test in the male gender, with an initial result of 15.75 compared to 15.63 seconds in the final test. A comparison of the final results between the two schools, using Student t test with a value of $p < 0.05$, showed no statistically significant difference between the final results of the agility T test in the male gender.

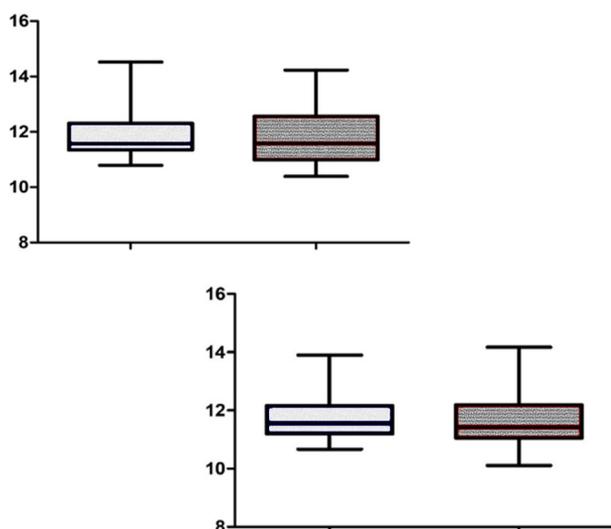


Fig. 4 – Initial and final results in the "L" test, in male subjects, between the two schools, in seconds.

Analyzing the results obtained by both schools (Table IV and Fig. 4) shows that School "George Popa" had an improvement of 0.18 seconds between the initial and final results in the agility L test in the male gender, with an initial result of 11.93 seconds compared to 11.75. School "Mihai Eminescu" registered an improvement of 0.15 seconds between the initial and final results in the agility L test in

the male gender, with an initial result of 11.79 correlated with 11.64 seconds in the final test. Comparing the final results between the two schools, using the Mann-Whitney test with a value of $p > 0.05$, no statistically significant difference was found between the final results of the agility T test in the male gender.

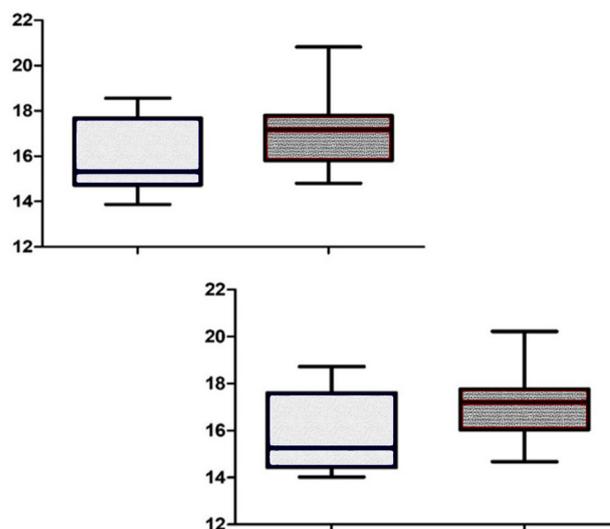


Fig. 5 – Initial and final "T" test results in female subjects, between the two schools, in seconds.

The next step was to analyze the findings obtained by both schools in the agility T test - female gender (Table V and Fig. 5). It can be observed that School "George Popa" had an improvement of 0.12 seconds between the initial and final results in the agility T test in the female gender, with an initial result of 16.05 seconds compared to 15.93 at the final evaluation. School "Mihai Eminescu" showed an improvement of 0.04 seconds between the initial and final measurements of the agility T test in the female gender, with an initial outcome of 17.10 compared to 17.06 seconds in the final test. Comparing the final results between the two schools, using Student t test with a value of $p > 0.05$, evidenced a statistically significant difference between the final results of the agility T test in the female gender (Fig. 7).

Table VI

The results of the "L" test, initial and final, in female subjects, between the two schools.

L Test Initial	Female gender		L Test Final	Female gender	
	George Popa school	Mihai Eminescu school		George Popa school	Mihai Eminescu school
Mean	12.44	12.19	Mean	12.24	12.04
Std. deviation	1.135	0.8010	Std. deviation	1.138	0.7724
P value	0.3352		P value	0.4943	

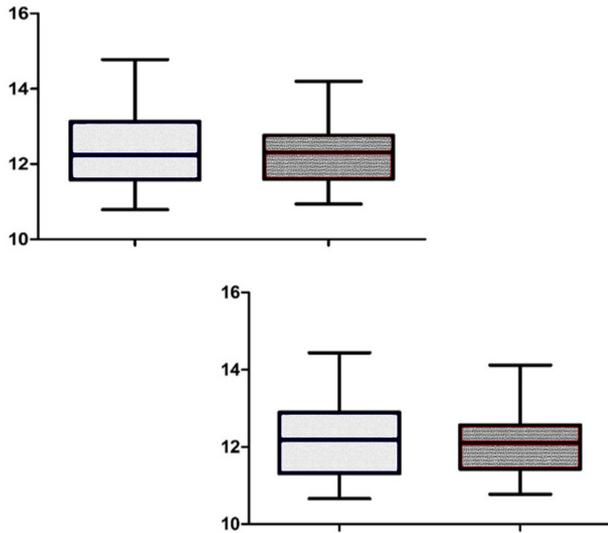


Fig. 6 – The "L" test, initial and final, in female subjects, between the two schools, in seconds.

At the final evaluation, we correlated the findings obtained by both schools in the agility L test - the female gender (Table VI and Fig. 6): School "George Popa" had an improvement of 0.20 seconds between the initial and final measurements in the agility L test for the female gender, with an initial result of 12.44 seconds compared to 12.24 at the final evaluation. School "Mihai Eminescu" had an improvement of 0.15 seconds between the initial and final results in the agility L test for the female gender, with an initial result of 12.19 compared to 12.04 seconds in the final test. Comparing the final results between the two schools, using the Welch correction with a value of $p > 0.05$, no statistically significant difference was found between the final data of the agility L test in the female gender (Fig. 8).

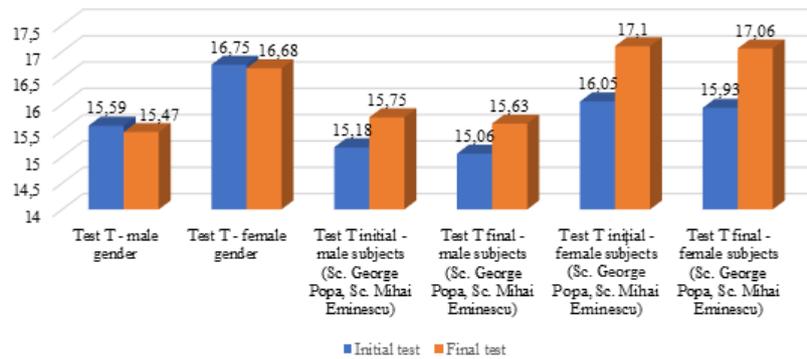


Fig. 7 – Comparison of initial and final T test values.

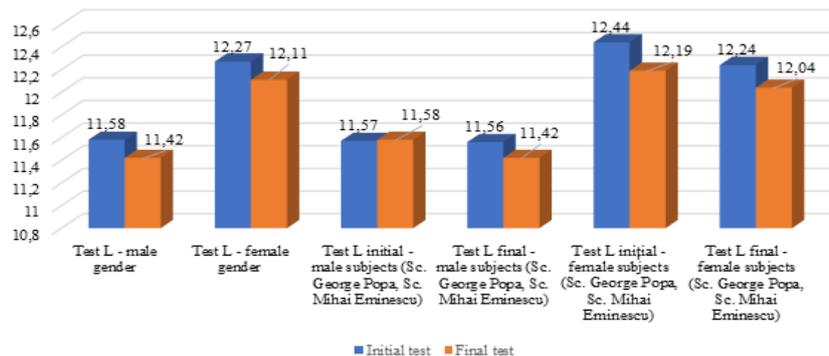


Fig. 8 – Comparison of the values of the L-test—initial and final.

Discussions

The importance of building motor qualities is an increasingly common topic in research studies, demonstrating each time the positive effects that result from their education.

The motor capacity of an individual adds up to a series of motor manifestations (skills), which, depending on their level of growth, influence the level of efficiency in performing a series of motor acts or actions. This idea was also studied by B. Sebastian in his paper entitled "Study on developing speed and skill through movement games in the basketball game."

In the literature, the importance of developing the nervous system during childhood is discussed very often, stressing that this is the crucial age at which the structures of neurons and the connections between them develop most efficiently, resulting in an improvement of motor qualities based on the speed of nerve impulses.

Developing speed and coordination at an early age, by teachers specialized in physical education and sports, prepares children for possible careers in the sports field, facilitating the work of coaches and thus avoiding stagnation of motor skills.

There is an increasing body of data that support the efficacy of training interventions to develop both the change of direction abilities (Brughelli et al., 2008) and the perceptual and decision-making aspects of agility (Serpell et al., 2011).

The results of the present research indicated significant improvements between the initial and the final examination in both agility tests, agility T test and agility L test. We compared the initial and final results in male subjects and female subjects and then we compared the results in males and females between the schools to see if any statistically significant difference could be found. The results showed a statistically significant difference in comparing the median time obtained by the male gender at the agility T test initial and final evaluation, which was considered, using Student t test with a value of $p < 0.05$, to be statistically significant; also, other statistically significant differences were found in the male gender in the agility L test, using Student t test with a value of $p < 0.05$, statistically significant. Other statistically significant differences were found by comparing the initial and final results in the female gender at the agility T test initial examination. The average result was 16.75 seconds compared to the final result which was 16.68 seconds, with an improvement of 0.07 seconds from the initial to the final test.

Other recent studies found no statistically significant differences in the level of agility between subjects practicing different sports games such as basketball, volleyball or soccer (Horicka et al., 2014). Some scientific papers discovered that agility manifests specifically in many sports; in judo, the agility to start, stop and change direction of movement requires one or maybe two small steps, taken quickly and dynamically to attack the opponent and reach the throwing position; conversely, a tennis player needs 4–5 steps to reach the coming ball (Inglis & Bird, 2016) and a soccer player needs many steps (Taylor et al., 2017). Straight line sprinting does not translate to

enhanced agility performance and instead supports the position in that linear running speed and jumping ability (Popowczak, 2019).

Conclusions

1. In conclusion, based on the studies carried out, it can be said that the development of speed and coordination in children in the primary cycle is essential for their good growth and evolution, thus managing to ensure a high motor capacity.

2. Motor skills can also be developed through testing systems similar to those performed in this research; they have very high attractiveness among students. The spirit of competition was extremely pronounced throughout the physical education hours, students wishing to achieve performances that would place them in front of the class.

3. Another conclusion is that the results of these tests can bring valuable information to teachers. For example, students who have had a good time in both tests have very high speed and coordination indices, being recommended to be guided by the specialist teacher to a certain branch of sport, such as basketball, handball, football, etc.

4. Such exercises help students develop their spirit of self-awareness, appreciating the individual value they have from a motor point of view, in some cases even inspiring them the desire to progress, with the purpose of overcoming their colleagues.

5. The conclusions of our experiment showed that the hypothesis was confirmed that the implementation of specific programs for the improvement of the combined motor qualities, speed and coordination (agility), can improve those skills and allow obtaining significantly better results in the two applied tests, between the initial and the final testing. Developing agility at young ages can contribute to a future athlete's sport career by building a strong foundation of motor skills.

References

- Allum J, Carpenter M, Honegger F, Adkin A, Bloem B. Age-dependent variations in the directional sensitivity of balance corrections and compensatory arm movements in man. *J Physiol.* 2002; 542(Pt 2):643-663. doi: 10.1113/jphysiol.2001.015644.
- Andersen LB, Bugge A, Dencker M, Eiberg S, El-Naaman B. The association between physical activity, physical fitness and development of metabolic disorders. *Int J Pediatr Obes.* 2011;6 (Suppl 1):29-34. doi: 10.3109/17477166.2011.606816.
- Brughelli M, Cronin J, Levin G, Chaouachi A. Understanding change of direction ability in sport: A review of resistance training studies. *Sports Med.* 2008;38(12):1045-1063. doi: 10.2165/00007256-200838120-00007.
- Fisher A, Reilly JJ, Kelly LA, Montgomery C, Williamson A, Paton JY. Fundamental movement skills and habitual physical activity in young children. *Med Sci Sports Exerc.* 2005;37(4):684-688. doi:10.1249/01.mss.0000159138.48107.7d.
- Gallahue DL, Ozmun JC. *Motor Development: A theoretical model. Understanding motor development: infants, children, adolescents, adults.* 5th ed. New York: McGraw-Hill, 2002.
- Hantiu I. *Kinesiologie-Știința mișcării* Ed. Univ Press, Oradea, 2013a.
- Hanțiu I. *Educație fizică și sport - Teorie și metodică.* Ed Univ

- Press, Oradea, 2013b.
- Hestbaek L, Leboeuf-Yde C, Kyvik KO, Manniche C. The course of low back pain from adolescence to adulthood: eight-year follow-up of 9600 twins. *PubMed Spine*. 2006;31(4):468-472. doi: 10.1097/01.brs.0000199958.04073.d9.
- Horicka P, Simonek J, Hianik J. The relationship between speed factors and agility in sport games. *J Hum Sport Exerc*. 2014;9(1):49-58. DOI: 10.4100/jhse.2014.91.06.
- Inglis P, Bird SP. Reactive agility tests-Review and practical applications. *J Aust. Strength Cond.*, 2016;24(5):62-69.
- Krombholz H. Motor and cognitive performance of overweight preschool children. *Percept Mot Skills*. 2013;116(1):40-57. doi: 10.2466/22.25.PMS.116.1.40-57.
- Lubans DR, Morgan PJ, Cliff DP, Barnett LM, Okely AD. Fundamental movement skills in children and adolescents: review of associated health benefits. *Sports Med*. 2010;40(12):1019-1035. doi: 10.2165/11536850-000000000-00000.
- Měkota K. Definition and structure of motor abilities. *Czech kinanthropology*. 2000;4(1):59-69.
- Neagu N. *Motricitatea umană: Fundamente psihopedagogice*, Ed Univ Press, Târgu Mureș, 2012.
- Plisk SS. Speed, agility and speed endurance development. In T.R. Beatchle and R.W. Earle (Eds.), *Essential of Strength Training and Conditioning*. Champaign, IL: Human Kinetics, 2000.
- Popowczak M, Rokita A, Świerczko K, Szczepan S, Michalski R, Maćkała K. Are Linear Speed and Jumping Ability Determinants of Change of Direction Movements in Young Male Soccer Players? *J. Sports Sci. Med*. 2019;18(1):109-117.
- Serpell BG, Young WB, Ford M. Are the perceptual and decision-making aspects of agility trainable? A preliminary investigation, *J Strength Cond Res*. 2011;25(5):1240-1248. doi: 10.1519/JSC.0b013e3181d682e6.
- Sheppard JM, Young WB. Agility Literature Review: Classifications, Training, and Testing. *J Sports Sci*, 2006; 24(9):919-932. DOI:10.1080/02640410500457109.
- Sporis G, Milanovic L, Jukic I, Omrcen D, Molinuevo J. The effect of agility training on athletic power performance; *Kinesiology*, 2010;42(1):65-72.
- Taylor JB, Wright AA, Dischiavi SL, Townsend MA, Marmon AR. Activity Demands During Multi-Directional Team Sports: A Systematic Review. *Sports Med*. 2017;47(12):2533-2551. doi: 10.1007/s40279-017-0772-5.
- Van Gelder LH, Bartz SD. The effect of acute stretching on agility performance. *J Strength Cond Res*. 2011;25(11):3014-3021. doi: 10.1519/JSC.0b013e318212e42b.
- Vos T, Flaxman AD, Naghavi M, Lozano R, Michaud C, Ezzati M. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: a systematic analysis for the Global Burden of Disease Study. *Lancet*. 2010;380(9859):2163-2196. doi: 10.1016/S0140-6736(12)61729-2.
- Williams HG, Pfeiffer KA, O'Neill JR, Dowda M, McIver KL, Brown WH. Motor skill performance and physical activity in preschool children. *Obesity*. 2008;16(6):1421-1426. doi: 10.1038/oby.2008.214.
- Young WB, James R, Montgomery I. Is Muscle Power Related to Running Speed with Changes of Direction? *J Sports Med Phys Fitness*. 2002;42(3):282-288.